Chapter 1. SUMMARY OF THE PLAN AND RECOMMENDATIONS FOR ACTION

This report summarizes the results of an intensive study of the subsurface agricultural drainage problems of the western side of the San Joaquin Valley, and presents a plan and recommendations for managing those problems from 1990 to 2040. The study has led to a much better understanding of the causes and effects of the drainage and drainage-related problems, although much is yet to be learned and long-term monitoring of the problem will be necessary.

The study and resulting plan focus on in-valley management of the drainage and drainage-related problems. It appears that in-valley actions can manage the problems for several decades without a means of exporting drainage-related salts to the ocean. Ultimately, it may become necessary to remove salt from the valley.

The recommended plan, which is regional in both scope and detail, takes account of uncertainties in information. The plan is not site-specific, and, without more detailed analysis, it is not a plan from which structures may be built. Rather, it should be considered as a framework that will permit the present level of agricultural development in the valley to continue, while protecting fish and wildlife and helping to restore their habitat to levels existing before direct impact by contaminated drainage water. It is noteworthy that many of the valley's water and drainage districts and individual growers have already begun to take actions similar to those recommended in this report.

Figure 1 shows the San Joaquin Valley, the principal study area, and the five subareas used for planning.

SUMMARY OF THE PLAN

The plan recommended for management of subsurface drainage and drainage-related problems on the western side of the San Joaquin Valley contains the following major components:

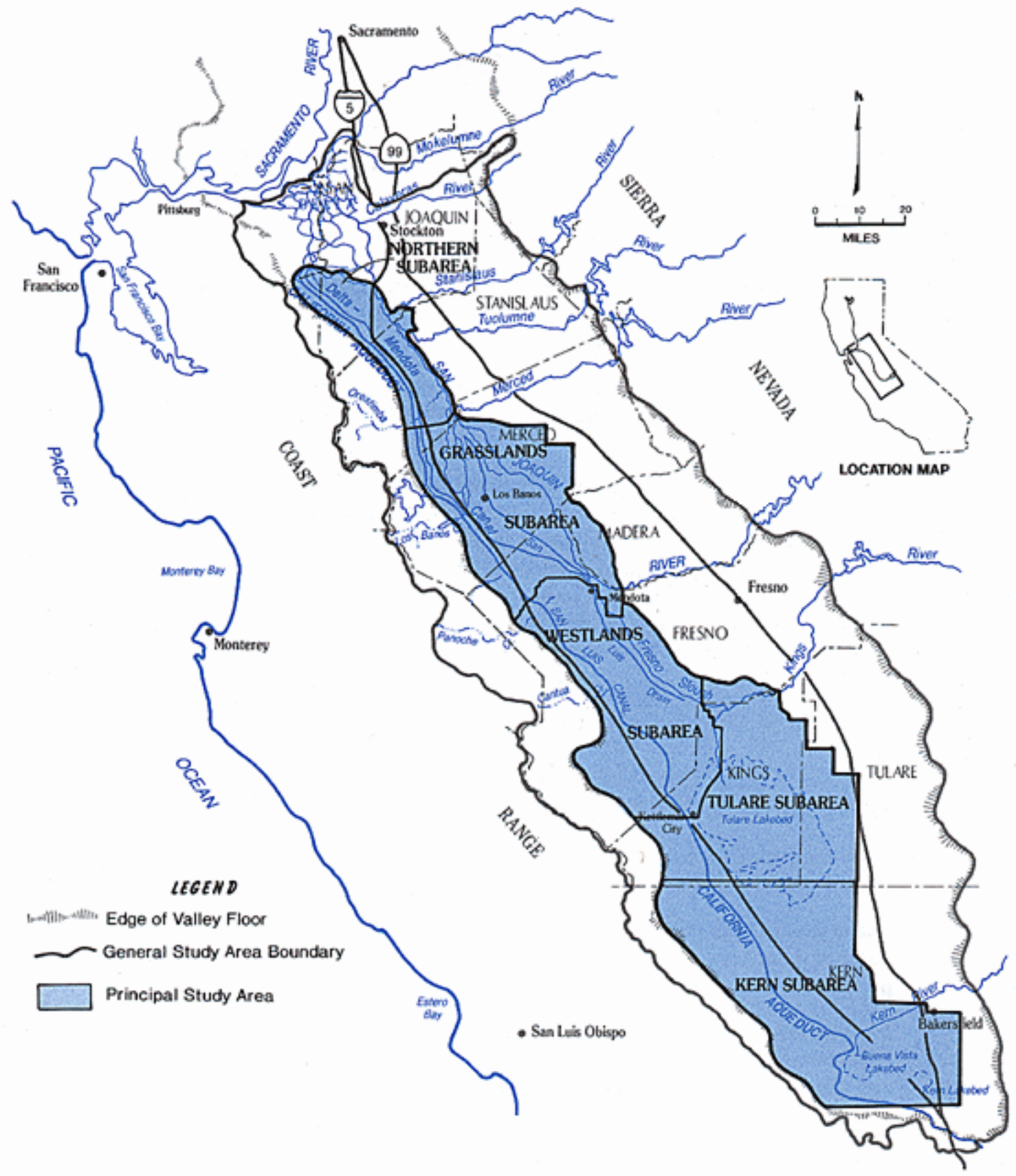
- ***Source control.*** Consisting mainly of on-farm improvements in the application of irrigation water to reduce the source of deep percolation. This in turn will reduce the amount of potential drainage problem water.

- ***Drainage reuse.*** A planned system of drainage-water reuse on progressively more salt-tolerant plants. This will reduce the volume of drainage water and concentrate salts and trace elements for easier containment and safe disposal.

- ***Evaporation system.*** Drainage-water evaporation ponds planned for storage and evaporation of drainage water remaining after reuse on salt-tolerant plants. Four types of ponds are included: (a) Nontoxic ponds in which selenium in drainage-water

Figure 1

PROGRAM STUDY AREA



inflow is less than 2 parts per billion (ppb); (b) selenium-contaminated ponds (inflowwater containing selenium in the range of 2 to 50 ppb) that must include safeguards for wildlife and an equivalent area of alternative freshwater habitat; (c) small selenium-contaminated ponds designed with facilities to greatly accelerate the rate of evaporation, thereby reducing the pond surface area; and (d) temperature-gradient solar ponds that generate electricity by using water from other ponds containing very high salt and trace-element concentrations.

- ***Land retirement.*** Cessation of irrigation of areas in which underlying shallow ground water contains elevated levels of selenium and the soils are difficult to drain.
- ***Ground-water management.*** Planned pumping from deep within the semiconfined aquifer, in places where near-surface water tables can be lowered and the water pumped is of suitable quality for irrigation or wildlife habitat.
- ***Discharge to the San Joaquin River.*** Controlled and limited discharge of drainage water from the San Joaquin Basin portion of the study area to the San Joaquin River, while meeting water-quality objectives.
- ***Protection, restoration, and provision of substitute water supplies for fish and wildlife habitat.*** Provision of freshwater supplies to substitute for drainage-contaminated water previously used on wetlands and to allow protection and restoration of contaminated fisheries and wetland habitat.
- ***Institutional change.*** Includes tiered water pricing, improved scheduling of water deliveries, water transfers and marketing, and formation of regional drainage management organizations to aid in implementing other plan components.

Table 1 summarizes the extent to which each plan component is included in the plan, based on the land area to which it applies or occupies and the water assigned for fish and wildlife uses.

Table 1. SUMMARY OF RECOMMENDED DRAINAGE MANAGEMENT PLAN

Plan Component	Subarea					
	Northern[a]	Grasslands	Westlands	Tulare	Kern	Total
	Land areas in 1,000s of acres by 2040					
Source Control	0	93.6	159.3	316.7	105.9	675.5
Drainage Reuse[b]	0	2.6	12.1	24.5	9.7	48.9
Evaporation System[b]	0	0.2	2.1	3.0	2.3	7.6
Evaporation Pond[b]	0	0.12	0.40	2.9	1.07	4.5
Alternative Habitat						
Land Retirement	0	3.0	33.0	7.0	32.0	75.0
Ground Water Management	0	10.0	19.0	40.0	0.0	69.0
Discharge to San Joaquin River (land area)	0	160.6	0	0	0	160.6
	1,000s of acre-feet annually by 2040					
Increased Water for Fish and Wildlife Uses, Including Substitute Water[c]	0	150.0[d]	4.0[e]	29.0[e]	11.0[e]	194.0

[a] Except for study and monitoring, no planned drainage management actions are recommended for the Northern Subarea.
[b] The acreages shown are for on-site facilities; the total land area served is essentially all the area under source control.
[c] Substitute water is that water supply for wetlands that replaces contaminated drainage water used through the mid-1980s.
[d] Consists of 129,000 acre-feet of substitute water supply for wetlands, 20,000 acre-feet of Merced River instream fish flow in October, and 1,000 acre-feet of evaporation pond alternative habitat.
[e] Water for evaporation pond alternative habitat at the rate of 10 acre-feet/acre/year.

No planned drainage management actions other than those being carried out currently are recommended for the Northern Subarea. However, drainage water from this area now flows to the San Joaquin River. In the event that water-quality objectives for the river become more restrictive, actions that would aid in meeting the objectives are discussed in the subarea plan.

Problem water is a term introduced in this report to describe the volume of near-surface ground water that, if reduced by source control or removed from plant root zones each year, would eliminate the drainage-related impediment to agricultural productivity. When placed in streams or open basins, some problem water is potentially hazardous to fish and wildlife and therefore must be managed to prevent environmental degradation. Drainage water that causes unacceptable levels of environmental degradation is viewed also as problem water for agriculture because it must be remedied — even if retirement of irrigated land is required. Table 2 shows the estimated reduction of problem water to be achieved by each plan component in each subarea. If the targets are met, agricultural production could be maintained for at least the duration of the planning period, without removal of salt from the valley. If salt export becomes necessary in the future, the actions recommended in this plan could create prerequisite conditions by providing collection facilities, by reducing drainage water volumes, and by isolating and controlling contaminants.

Table 2. PROBLEM WATER REDUCTION, 2040

Plan Component	Subarea								
	Northern	Grasslands		Westlands		Tulare		Kern	
		Acre-feet	Percent of Total	Acre-feet	Percent of Total	Acre-feet	Percent of Total	Acre-feet	Percent of Total
Source Control	0	32.7	(21)	55.8	(36)	63.2	(30)	37.1	(34)
Drainage Reuse	0	13.6	(9)	61.0	(40)	113.3	(54)	43.6	(39)
Evaporation System	0	0.7	—	4.0	(3)	12.3	(6)	6.0	(5)
Land Retirement	0	2.3	(1)	24.8	(16)	4.2	(2)	24.0	(22)
Ground-water Management	0	4.0	(3)	7.6	(5)	16.0	(8)	0	(0)
Discharge to San Joaquin River	0	102.1	(66)	0	(0)	0	(0)	0	(0)
TOTAL		**155.4**	**(100)**	**153.2**	**(100)**	**209.0**	**(100)**	**110.7**	**(100)**

a Except for study and monitoring, no planned drainage management actions are recommended for the Northern Subarea.

The costs of the recommended plan have been annualized over the 50-year planning period, 1990-2040, at an interest rate of 10 percent (Table 3). One-time costs include those for installation of facilities and purchase (as in the case of land retirement) of plan components. The category "Agricultural Drainage" includes all drainage-related components of the recommended plan, except on-farm drainage systems. "On-Farm Drains" includes new on-farm drainage systems expected to be installed between 1991 and 2040 and the annual operation of those drains during that period, as well as those already operating in 1990. "Fish and Wildlife" includes the costs of constructing and operating facilities and purchasing water so that clean water could be delivered to wetland habitat formerly supplied with contaminated drainage water.

The economic value of the direct benefits or regional economic impacts of implementing the recommended plan was not estimated, and no allocation of costs among beneficiaries has been

performed. For drainage reuse, an estimate of the value of wood produced has been reflected as a cost offset. However, for source control and land retirement, any economic surplus that might result from the possible transfer of conserved water to other uses has not been included as a cost offset.

Table 3. ANNUALIZED COSTS OF THE RECOMMENDED PLAN
In $1,000s

Agricultural Drainage	
One-time	
Source control	2,940
Drainage reuse	6,194
Evaporation system	3,043
Land retirement	2,818
Ground-water management	962
San Luis Drain	2,300
Subtotal	18,257
Operation, maintenance, and replacement	
Source control	5,444
Drainage reuse	2,291
Evaporation system	1,915
Land retirement	300
Ground-water management	2,694
San Luis Drain	390
Subtotal	13,034
TOTAL	**31,291**
On-Farm Drains	
Installation	6,473
Operation, maintenance, and replacement	1,536
TOTAL	**8,009**
Fish and Wildlife	
Installation	153
Operation, maintenance, and replacement	18
Water supply	2,548
TOTAL	2,719
GRAND TOTAL	**42,019**

CONCLUSIONS AND RECOMMENDATIONS FOR ACTION

During this study, a massive amount of data has been collected; many reports have been published; and much analysis, planning, and public review have been completed. This has led to the plan for drainage management presented in Chapter 6. However, a plan alone will not manage or solve the drainage and drainage-related problems of the western side of the San Joaquin Valley; actions are required on many fronts to make the plan a reality. These actions can be grouped under implementation, planning, monitoring, additional study, and funding proposed actions. The conclusions and recommendations for action that follow are presented in each of those groups.

Implementation

Local initiatives need to be recognized, supported, and enhanced by coordinated, comprehensive Federal and State actions undertaken to manage drainage problems. Several components in the management plan are either being studied preparatory to action or are actually being carried out by organizations and private interests in the problem area. Those activities that meet the criteria and objectives of the long-term drainage management plan should be carried out as rapidly as possible. Generally, these activities will require approval or assistance from local, State, or Federal agencies. They should receive high priority.

Some changes in law and policy by local, State, and Federal agencies would provide the impetus or remove roadblocks for implementing some plan components. Policy actions by agencies supplying, distributing, and regulating irrigation water and managing drainage facilities are needed now and in the future. Institutional changes are also a part of the management plan, which requires concerted action by both the California Legislature and the U.S. Congress.

Because unattended plans often do not materialize, the efforts reported here will be followed by a short, new Federal-State effort between October 1990 and December 1991 that will develop a strategy for implementation of the plan.

Recommendation 1 – Implementation of Recommended Plan; Priority Activities

Local, State, and Federal water organizations and authorities should consider the recommended plan and explicitly adopt those parts appropriate for their long-term strategy of contributing to the management or solution of the drainage problems of the west side San Joaquin Valley.

The following plan components should be implemented as soon as final planning is complete, funding and applicable clearances can be obtained, and agreement can be reached. An asterisk (*) following a plan component indicates there is a related current local initiative that should become part of the plan component.

Northern Subarea

- Investigate, in detail, measures that may be needed if stricter salt standards are established for the San Joaquin River/Delta.

Grasslands Subarea

- Use the Grassland Task Force water districts as the nucleus of a regional drainage entity to coordinate and jointly manage subarea–wide drainage problems. *
- Provide the facilities required to intercept contaminated subsurface drainage water now being discharged into open channels within the grasslands wildlife habitat, and convey these to the San Luis Drain.
- Renovate and extend the San Luis Drain, bypassing 20,000 acre-feet of contaminated drainage water around wetlands (similar to the Zahm-Sansoni-Nelson plan). *
- Improve on-farm water conservation and source control on all irrigated lands and reduce deep percolation on lands having drainage problems by 0.35 acre-feet per acre per year (on the average) as soon as possible. *
- Intensify and complete local demonstration projects on source control and treatment of drainage water. (Work already under way in Broadview, Panoche, and Pacheco water districts.) *
- The U.S. Bureau of Reclamation should actively seek authority to reallocate 74,000 acre-feet of water annually from the Central Valley Project to replace drainage water used on wetlands before 1985.
- Restore drainage-contaminated wetlands.
- Provide 20,000 acre–feet of water to the Merced River each October to attract migrating fish from drainage water discharging to the San Joaquin River.

Westlands Subarea

- Improve on-farm water conservation and source control on all irrigated lands and reduce deep percolation on lands having drainage problems by 0.35 acre-feet per acre per year (on the average) as soon as possible. *
- Accelerate the pace and increase the number of field demonstrations of source control measures and drainage water treatment research, including especially reuse of drainage water on trees and removal of selenium from drainage water. *
- Develop guidelines for retirement of irrigated lands that have high selenium concentrations in shallow ground water and that are difficult to drain.
- Design and develop a 5,000-acre demonstration unit of closely-spaced, low-volume wells in the semiconfined aquifer for planned drawdown of the high water table.

Tulare Subarea

- Develop a formal association of water districts (built around the existing Tulare Lake Drainage District) for coordinated and joint management of subarea-wide drainage problems. *
- Improve on-farm water conservation and source control on all irrigated lands and reduce deep percolation on lands having drainage problems by 0.2 acre-feet per acre per year (on the average) as soon as possible. *

- Accelerate the pace and increase the number of field demonstrations of source control measures and evaporation pond experiments, including especially the reuse of water on trees and modification of pond systems and their management to make ponds bird–free or bird–safe. *
- Demonstrate in the field the use of alternative safe-water habitat near an existing evaporation pond containing elevated levels of selenium.
- Design and develop a 5,000-acre demonstration unit of closely-spaced, low-volume wells in the semiconfined aquifer for planned drawdown of the high water table in the area of good quality ground water in the Kings River Delta (Tulare Subarea water quality zone E).

Kern Subarea

- Kern County Water Agency and local water districts should form a drainage management entity responsible for coordination and joint management of subarea-wide drainage problems.
- Improve on-farm water conservation and source control on all irrigated lands and reduce deep percolation on lands having drainage problems by 0.35 acre-feet per acre per year (on the average) as soon as possible. *
- Initiate intensive studies of the ground–water resources of the old Buena Vista and Kern lakebeds.

Recommendation 2 – Source Control

The agencies with major responsibility for delivery of water to the study area (U.S. Bureau of Reclamation and California Department of Water Resources) should increase their work with the university extension systems and water districts to demonstrate ways to improve the efficiency of irrigation water application and thereby reduce potential drainage-water volumes.

Each water district should, by 1992, set objectives in their operation plans that would reduce deep percolation by the amounts stated in Recommendation 1 (preceding). State and Federal agencies should help local water districts accomplish their water conservation improvement plans.

Recommendation 3 – Financing Source Control Measures

Both the Federal and State governments should explore ways of providing a portion of the financing needed to implement irrigator source–control actions and to invigorate existing programs. The U.S. Soil Conservation Service and U.S. Bureau of Reclamation both have programs that could aid in financing irrigator actions. The State of California, through the Department of Water Resources, the Department of Food and Agriculture, and the State Water Resources Control Board, could provide loans and grants for source-control actions, if funds were made available.

Recommendation 4 – Joint Technical Assistance

The U.S. Department of the Interior and the State of California should jointly develop a technical assistance program to ameliorate the drainage problem, by providing water districts with geohydrologic and economic information and analytical techniques useful in investigating local areas for possible conjunctive surface- and ground-water use, land retirement, on-farm drainage, source control, and reuse. Technical assistance is also needed in environmental impact assessment, toxicity assessment, and habitat restoration.

Recommendation 5 – State of California Lead in Water Conservation

The State of California should expand and intensify its program of on-farm water conservation to focus especially on demonstrating alternative source control measures on drainage-problem lands.

Recommendation 6 – Federal and State Programs' Adjustment

The State of California and the U.S. Department of the Interior should jointly consider the findings, forecasts, and plans of the Drainage Program with respect to drainage problems, and should look for opportunities to encourage amelioration and resolution of these problems. This should be achieved through ongoing operations, planning, construction, and — if considered necessary — new legislation, promulgation of rules and regulations, and appropriate language in contracts and administrative reviews.

Recommendation 7 – Western U.S. Applications

The U.S. Department of the Interior should consider the information, techniques, and experience accumulated in the Drainage Program and extend appropriate aspects of the knowledge base to other land areas in the western United States that are experiencing similar agricultural drainage and drainage-related problems.

Planning

The general plan for reducing or solving drainage and drainage-related problems outlined in this report provides a framework into which many actions can be fitted. However, before many of the actions can move forward, additional work is needed to refine estimates of their scope and effects. Generally, this additional planning will occur at local, State, and Federal levels, and at combinations of each.

Recommendation 1 – Water District Plans

With financial and technical assistance from State and Federal agencies, water districts should lead in developing plans to:

- Identify lands in drainage problem areas in which the combined characteristics of high concentrations of selenium and difficult-to-drain soils would make these lands candidates for retirement from irrigation.
- Identify locations in drainage problem areas where there may be an opportunity to lower the high water table by pumping from deep in the semiconfined aquifer (above the Corcoran Clay), and design the facilities, reach agreements, and obtain policy approvals required to carry out pumping.

Recommendation 2 – State Water Project Area

Within the State Water Project service area, the State of California should lead in planning for the regional drainage-water treatment and disposal needs that will arise from management and reuse of drainage water within local water districts.

Recommendation 3 – Federal Water Service Area

Within the Federal water service area, the Department of the Interior should lead in planning for the regional drainage-water treatment and disposal needs that will arise from management and reuse of drainage water within local water districts.

Recommendation 4 – Joint Planning for Ground–Water Management

Plans for installation and operation of well fields designed to pump from the semiconfined aquifer to lower the high water table should be completed cooperatively by Federal and State agencies and water districts. In the Federal service area, the Bureau of Reclamation should work with Westlands, Broadview, Panoche, San Luis, and Firebaugh Canal water districts to design well fields for areas identified in this report. In the State service area, the Department of Water Resources should work with Kern County Water Agency and Empire Westside, Riverside, Stratford, and Laguna irrigation districts, Lakeside Irrigation Water District, Kings County Water District, and Kings River Conservation District for the same purpose. Services of the U.S. Geological Survey should be used in locating favorable areas and in developing plans.

Recommendation 5 – Joint Planning for Water Delivery

Federal and State fish and wildlife agencies, in cooperation with private wetland owners, and Federal and State water development agencies should jointly plan the facilities required for delivery of water to wildlife areas affected by subsurface drainage water.

Monitoring

To properly implement management of drainage and drainage-related problems, both the problems and the progress in solving them must be monitored. This is especially important because of the changing nature of the drainage problem and the flexible array of measures required for management. Monitoring all aspects of the problem and the effects of management will be critical to using the plan as a flexible guide to remedial actions.

Recommendation 1 – Local Water Agencies

All local water supply and drainage agencies should participate in joint, coordinated programs to monitor the volume and quality of drainage water in the collection, treatment, and/or disposal systems.

Recommendation 2 – Joint State/Federal

The U.S. Department of the Interior and the State of California should jointly design a scientifically reliable and cost-effective network of physical and biological monitoring stations that will detect change in the environment caused by subsurface agricultural drainage problems and attempts to solve these problems. Areas expected to experience expansion of high water tables should be included.

Additional Study

During the six-year life of the Drainage Program, the absence of reliable information made it necessary for the Program to fund basic research, as well as to fund investigations directly relevant to solving drainage problems. Some additional study is needed to provide detailed information for feasibility determinations.

Recommendation 1 – Study Needs

Water and land managers, universities, agencies, and individuals should emphasize the following study categories and subjects, and support the development of information transfer programs to extend study results to appropriate user groups.

Drainage Management

- Develop measures to renovate or close aged or toxic evaporation ponds.
- Develop a cost-effective treatment method to remove selenium from drainage water.
- Perform field tests of tolerance of agricultural crops, halophytes, and salt-tolerant trees to constituents in drainage water.
- Develop effective training programs for personnel involved in drainage management.
- Investigate the propagation and marketing of salt-tolerant crops that use saline drainage water as an irrigation supply.
- Demonstrate the use of an accelerated evaporation system, using a sprinkler system similar to the University of Texas at El Paso's experimental system and the use of a temperature-gradient solar pond system for salt disposal and generation of electricity.

Geohydrology

The following studies are interrelated by the nature of the geohydrologic system. The objective is to better understand the surface- and ground-water system's chemical and physical characteristics that will allow better management of the natural resources.

- Evaluate, in detail, the areal and vertical variability of ground-water quality in the Tulare Subarea and in all water-quality zones considered for the ground-water management component in the plan.
- Investigate solubility controls for specific elements of concern (selenium, arsenic, molybdenum, and uranium) in various geologic conditions. Specifically, expand studies to include basin and lacustrine environments that dominate the Tulare Basin where drain water disposal options are severely limited and conditions are highly varied.

- Develop reliable, consistent methods for estimating ground water pumping.
- Complete investigation of surface water and ground water interaction in the San Joaquin River so that the quantity, quality and timing of ground-water contributions to river flows can be evaluated.
- Complete development of a streamflow and solute transport model for the San Joaquin River and couple it with reservoir operations models so that management alternatives can be evaluated.
- Determine the capacity of geochemically reduced Sierra Nevada sediments to remove selenium.
- Determine the hydraulic and water-quality feasibility of controlling the water table by pumping from wells in selected areas.
- Continue development of quantitative analyses of ground water flow systems.

Economics

- Use the surface and subsurface conjunctive-use model of the San Joaquin Valley (as developed for the Drainage Program) to evaluate water transfers and marketing scenarios.

Fish and Wildlife

Contamination. Continue the effort initiated by the Program to determine the nature, geographic extent, and severity of contamination of fish, wildlife, and their habitats by subsurface drainage water. Special attention should be given to: evaporation ponds and neighboring public and private wildlife areas; agroforestry plantations; the San Joaquin River, Delta, and San Francisco Bay; and the six substances of concern discussed in this report (arsenic, boron, chromium, molybdenum, selenium, and total dissolved solids) and ten additional trace elements and metals: cadmium, copper, lithium, manganese, mercury, nickel, strontium, uranium, vanadium, and zinc.

Toxicity. Continue the effort initiated by the Program to define, for fish and wildlife, safe and toxic concentrations (and associated biological effects) of subsurface drainage water substances of concern in water and food. Special attention should be given to: independent toxicity of trace elements other than arsenic, boron, and selenium (for example, cadmium, chromium, copper, lithium, manganese, mercury, molybdenum, nickel, strontium, total dissolved solids, uranium, vanadium, and zinc); interactive effects of trace elements in drainage water; effects of water chemistry (for example, pH and salinity) on independent and interactive toxicity; and site-specific toxicity (for example, in valley aquatic and wetland habitats, evaporation ponds, and agroforestry plantations).

Protection, restoration, substitute water supply, and improvement. Continue the effort initiated by the Program to identify and evaluate measures to: protect remaining fish and wildlife resources of the San Joaquin Valley from drainage-related impacts; restore drainage water contaminated habitats; provide water supplies to substitute for drainage water previously used by fish and wildlife; and improve fish and wildlife resources.

Out-of-valley drainage water disposal. In the event that out-of-valley disposal is pursued in the future, develop information to assess the potential effects on fish and wildlife habitats and

populations, and public uses of those resources in the receiving waters and lands. In light of recommendations for consideration of disposal in these areas, special attention should be given to the Sacramento–San Joaquin Delta, San Francisco Bay, and the Pacific Ocean (CVRWQCB, 1988a; NRC, 1989).

Public Health

To adequately quantify the risks of environmental chemical exposures, substantial information is necessary on the environmental fate of the chemicals, the toxicity of specific forms, and the degree to which humans are exposed to them. Although site- and organism-specific data are always preferred, surrogate data are used frequently to fill data gaps (for example, animal studies are extrapolated to assess likely human toxicity resulting from a chemical exposure). The following summarizes information needed to best assess the probability of adverse human health effects related to drainage contaminant exposures.

Environmental fate

- Further identify chemical forms of substances of concern in different environmental media (air, water, soil, sediment, biota).
- Further identify environmental conditions (pH, oxidation-reduction, etc.) in which different chemical forms of substances of concern occur in different environmental media.
- Continue studies conducted by the University of California to assess the uptake of substances of concern into edible biota related to specific environmental conditions.
- Place research emphasis on the environmental fate of substances of concern via typical routes of human exposure (for example, food-chain transfer of organic forms of trace elements).

Toxicology

- Perform additional chronic toxicity testing on specific chemical forms of substances clearly associated with the drainage problem.

Exposure assessment

- Further identify contaminant threshold concentrations in edible animals in tissues used for human consumption.
- Further identify contaminant threshold concentrations in edible plants in tissues used for human consumption.
- Characterize consumption patterns of populations at risk.

Risk quantification

- Quantify option- and site-specific public health risks.

Funding Proposed Actions

There has been no formal discussion or analysis of the way in which components of the plan and the various actions recommended would be funded. Undoubtedly the costs would be shared by

the private and public sectors and it is essential that discussion begin soon of distribution of plan costs.

Recommendation 1 – Cost Allocation Principles

The following principles should be considered in discussing allocation of the costs of implementing the plan.

- All areas contributing to a problem of subsurface agricultural drainage water should share in the costs of resolution and management of that problem.
- With respect to contributing areas, the cost-sharing formulas should be based on best available scientific information, and they should be re-evaluated and updated periodically in light of new information.
- Both direct indicators (upslope–downslope hydraulic relationships, for example) and indirect indicators (water supply received, for example) should be considered for inclusion in cost-sharing formulas.
- All beneficiaries should pay for drainage-management costs in proportion to benefits received.
- There are both market and nonmarket national, State, and local benefits to be realized from the management of drainage problems. All beneficiaries should be identified.
- Because of the widespread occurrence of the drainage problem on the western side of the valley and the lack of scientific data on specific sites, costs should be distributed over the largest practicable land area — a whole service area or an association of water districts, for example — rather than one small water district.

Recommendation 2 – Study Plan Benefits

The U.S. Department of the Interior and the State of California should jointly study the benefits of implementation of the plan.

Recommendation 3 – Study Legislative Needs

The State of California should examine the need for new legislation to remove obstacles or to create opportunities for water marketing so that funds from water sales may be used for payment of drainage costs.